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UNITED STATES DEPARTMENT OF AGRICULTURE

BULLETIN No. 575

Contribution from the Bureau of Animal Industry
JOHN R. MOHLER, Chief

Washington, D. C. ▼ Reprint, October 10, 1919

STOCK-POISONING PLANTS OF THE RANGE

By

C. D. MARSH, Physiologist, Pathological Division

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PREFATORY NOTE.

It is well known that poisonous plants cause heavy losses of range animals. Statistics in regard to these losses are not available, but from estimates made in many localities it seems probable that the average loss must be as great as 3 to 5 per cent, while in some range States it rises to much higher figures. For example, it has been estimated that in Colorado the losses amount to a million dollars annually, while sheep growers in Wyoming have estimated their annual loss as 14.6 per cent.

These losses, too, are to a large extent of mature animals, those that are ready or nearly ready for the market, and for the rearing of which large sums have already been spent. The importance of these severe losses has been recognized by the United States Department of Agriculture and extended investigations and experiments have been undertaken to determine what plants were poisonous and under what conditions poisoning took place, and to formulate methods for preventing these deaths. This work has involved prolonged study, and is still in progress. Some very definite results have been obtained, however, and it has been shown that the heaviest losses are due to a comparatively small number of plants. If the stockmen and herders can recognize these plants and will act upon the information contained in the bulletins which have been published on the subject, there is no doubt that most of these losses can be avoided.

Presumably, for the sake of their own material interests, the owners of live stock will be glad to do all in their power to reduce the fatalities from these plants. At the present time, however, when it is a matter of supreme concern to conserve the national food supply, one of the most important elements of which is meat, it is especially

[1] Original issue July 23, 1918.

necessary to bring the industry of stock production to the highest possible stage of efficiency, and it becomes a civic duty for every owner of live stock to produce as much as possible.

As a factor to aid in the conservation of food, this bulletin has been prepared with a view to assisting in the ready recognition of the plants which are most to be feared, and with brief suggestions, by following which losses can be largely reduced.

While our knowledge of poisonous plants is still incomplete, if stockmen will make it a point to recognize the plants and instruct their herders, following out the suggested methods of treatment and prevention, it will result in a very material and important increase of the meat supply.

Plates VIII, XIII, XIV, XV, XXI, and XXIV are from paintings by F. A. Walpole, in the collection of the United States National Herbarium.

J. R. MOHLER,
Chief of Bureau.

INTRODUCTION.

Poisonous plants have been the cause of heavy losses among live stock on the range. Stockmen generally have recognized the fact, but in the past comparatively little has been done to avoid the losses. The first intimation of trouble has ordinarily been the finding of the dead carcasses, and while the men handling the stock have felt reasonably sure that certain plants were responsible, their knowledge of the plants was very meager, and the evidence against any particular plant was frequently insufficient. It was noticed that these losses were more apt to occur in certain seasons than in others, and it was assumed in some cases that the plant was more poisonous at certain stages of growth than at others. Many of the stockmen were entirely uncertain as to what plant caused the damage, and it was common to speak of the source of the trouble as "poison weed," in a general way, without any very definite idea as to what particular weed was responsible for the loss. Moreover, the investigations which have been carried out on the subject of range-poisoning plants have necessarily been somewhat narrow in scope. There is a popular misconception in regard to the quantity of a poisonous plant necessary to produce illness. It seems to be the general belief that any plant possessing poisonous properties must be violently toxic. It is not unusual to hear stories of poisoning of domestic animals by a very few leaves of a poisonous plant. As a matter of fact, most of the stock-poisoning plants in the United States produce illness only when eaten in considerable quantity. This explains why so many experimental tests of animals with poisonous plants have failed, since some of these plants can be eaten with no apparent harm, provided the quantity eaten at any one time is not sufficient to produce toxic effects.

The problems of plants poisonous to live stock seem to be very largely peculiar to North America. Although similar plants occur in the eastern continents, very little information could be drawn from European sources to aid the American stockman.

For some years the United States Department of Agriculture has been carrying on a series of experiments with poisonous plants, and there has been accumulated a considerable body of information, which, although necessarily incomplete, will be, it is hoped, of service to men handling live stock upon the open range.

It appears from these researches that, while the total number of poisonous plants growing in the West may be very large, the number to be dreaded by the stockmen is comparatively small, and in most cases it is not at all difficult to identify the plants which are to be avoided. Of course, most stockmen are not botanists and are not interested in the botanical distinctions of plants. Most of them, however, are good observers and can readily recognize these plants if the salient characteristics are brought before them in a manner which they can understand.

With the continued reduction of the area of stock ranges and the increasing value of live stock, the owners are of necessity handling the animals with greater care. The time has passed when a man will buy a few cows, turn them loose, and pay no more attention to them except to brand the calves and occasionally round up a few of them for market. It is becoming necessary for stock owners to be in constant touch with their animals upon the range, and it is no longer probable that a large number will die and the fact become known to the owner only after the lapse of weeks or months. Most of the mountain stock ranges at the present time are under the general direction of the Forest Service, and the officers of that bureau are constantly patrolling the territory under their direction, so that between this supervision and the riding by the employees of the stock owners, cattle and horses upon the range are kept under almost constant observation. Sheep, of course, have always been under the immediate care of a herder, and probably will continue to be attended to in the same general way.

Extensive acquaintance by the author with the conditions on the western ranges has shown that while harmful plants are known and avoided by some men, there are large regions in which these plants have never been recognized, in spite of the fact that losses have occurred year after year.

The object of this publication is to present in a brief and intelligible form such a description of the common or more important plants as can be understood by a person not in the habit of using technical terms. With this description is given a brief statement of the symptoms produced by the plant, the time at which the losses may be expected to occur, and the means, so far as they are known, of avoiding them. It is not intended to give any complete description of the plants or their effects. For this, reference must be made to the more detailed reports upon specific plants. In regard to most of

these our knowledge is at present on a firm basis of experimental proof. It has seemed best, however, to add to the list some plants which undoubtedly produce poisonous effects, but which have never been subjected to detailed experimental study.

LOCO PLANTS.

Without any doubt the most destructive of all the poisonous plants are those going under the general name of loco. That extensive losses of domestic animals have been caused by loco plants has been claimed for a long time, but it is only within the last few years that exact evidence, by careful experiments, has shown definitely that these plants produce the effect which has been popularly ascribed to them. A great deal of interest attaches to these plants because of their wide distribution and the large number of animals that have been poisoned by them, including cattle, horses, and sheep, and also because of the difficulty of actually proving the existence of a poisonous principle in the plants themselves.

The loco plant has had its place in romantic literature, as it has frequently been claimed that it produces the same effect upon human beings as upon the lower animals, and it has been a popular subject for the short-story writer. None of these stories of "locoed" men, however, has any substantial foundation.

The word loco is from the Spanish, meaning crazy, and was given to the plant because of its supposed effect upon its victims. Loco plants have been heard of in practically all the open-range country of the West, except in the higher mountains, and there is no doubt that under the term loco disease a large number of ailments have been included. Experimental proof, however, has shown that there is a disease occasioned by the loco plants, with distinct symptoms and with a definite outcome.

WHITE LOCO (OXYTROPIS LAMBERTI).

Of all the loco plants the most destructive is the "white loco," or "rattle-weed," *Oxytropis lamberti* of the botanists. This is not because of its greater toxicity, but because it grows in great abundance over a wide extent of territory and is poisonous not only to cattle and sheep but to horses. It is found in the Plains region east of the Rocky Mountains from Alaska to Mexico. Like all the loco plants, it belongs to the Leguminosæ or pea family, the family in which are found peas, beans, clovers, alfalfas, etc. It is a perennial plant, living two or three years or more, and has a long root system which enables it to withstand conditions of drought. The leaflets of the compound leaves are slender, more or less hairy, and of an olive-green color. Thrifty plants are a foot or more in height.

The spikes of flowers are borne on stems extending above the leaves and are commonly of a prevailing white color, hence its name

WHITE LOCO, OR "RATTLEWEED" (OXYTROPIS LAMBERTI).

This is the most destructive of all the loco plants, not because of its greater toxicity but because of its wide distribution, extending from Alaska on the north to Mexico on the south, and from the Continental Divide to the western part of Minnesota. It poisons horses, cattle, and sheep.

SACKETT & WILHELMS CORP. N.Y.

FIELD OF OXYTROPIS LAMBERTI.

This landscape, taken in Montana, is a typical one and shows with what great abundance *Oxytropis lamberti*, or white loco, grows under favorable circumstances. It grows in equal abundance in Wyoming and Colorado.

SACKETT & WILHELMS CORP. N.Y.

ASTRAGALUS DRUMMONDI.

This plant grows very abundantly in the same region as the white loco, and frequently is considered as one of the loco plants. Careful experimental work has proved that this plant is harmless.

of white loco. The corolla, however, is frequently streaked with purple; sometimes the calyx is red; and sometimes, particularly in mountain regions, the whole corolla may be of a deep violet or purple color. All gradations in color may be found between these extremes. When the plants are in fruit the pods rattle as one hits them in walking, very closely imitating the rattle of a rattlesnake, hence the name "rattle-weed."

Plate I is a picture of the white loco as found in the plains of Colorado. Plate II shows a field of the plant in blossom. The latter picture was taken in the Yellowstone Valley of Montana, but it could easily be duplicated in Wyoming or Colorado.

It is evident that where the plant occurs in these great numbers such a thing as eradication is impossible except by plowing over the whole country. If animals are turned loose in such a region as this they certainly will have an opportunity to obtain an abundance of loco.

ASTRAGALUS DRUMMONDI.

In Plate III is given a picture of *Astragalus drummondi,* which occurs in many regions in connection with the white loco and is frequently considered a loco plant. The plant is readily recognized by its coarse stems and yellowish flowers, both the flowers and pods being somewhat dependent. Many people consider this a dangerous plant, but extensive experiments by the Department of Agriculture have shown that it is entirely harmless and need not be feared. The picture is given here only that stockmen may be able to recognize it as a plant which need not be avoided.

OXYTROPIS BESSEYI.

Plate IV shows a picture of *Oxytropis besseyi.* This is a leguminous plant, rather common in the Yellowstone Valley, which is very closely allied to the white loco and is frequently mistaken for it. The flowers are of a deep-pink color, and the plant, while it grows in the same regions as the white loco, is found upon the arid barren summits of hills, the white loco growing most abundantly at slightly lower levels. The two plants intermingle to some extent, but after a little experience one is able to distinguish between them, as there are certain noticeable differences in the leaves. *Oxytropis besseyi* is known in Montana sometimes as the red loco, because of the color of the flowers. Although the plant is closely related to the white loco and grows in the same regions, there is abundant experimental evidence that it is harmless. It should not be considered as a loco plant. The writer considers that the term "loco" should be applied only to such leguminous plants as have been proved to have poisonous properties.

PURPLE LOCO (ASTRAGALUS MOLLISSIMUS).

This plant, popularly known as "purple loco," "woolly loco," and sometimes as "Texas loco," is one that has been historically known as the true loco. It is probably the first plant which was recognized as a loco dangerous to live stock. It does not grow north of Nebraska, and perhaps is most abundant in the Panhandle of Texas, although it is found in adjoining regions of New Mexico, Colorado, Kansas, and Nebraska. The leaflets are very hairy and are much broader than those of the white loco. The plant also has a true stem, while the white loco has sometimes been known as the "stemless loco."

Plate V shows a very small plant of this loco. The flowers are not as conspicuous as in the white loco, and the corolla is of a deep-purple color. The pods are shorter, thicker, and of a deep-brown color. Large plants of purple loco may under favorable circumstances be about a foot in height and perhaps 2 feet in diameter. It does not commonly grow in the great abundance characteristic of the white loco, but there are sometimes fairly extensive fields. Where it grows in connection with the white loco the purple loco is more inclined to grow at the lower levels, while the white loco is found upon the sides of elevations. Purple loco is particularly destructive to horses; cattle may be poisoned by it, too, although this is rarely the case, perhaps because cattle do not eat it very readily.

ASTRAGALUS DIPHYSUS.

Plate VI is a picture of *Astragalus diphysus*, which is a type of a number of loco plants growing in the Southwest. These plants differ in their appearance very markedly from the white and purple locoes, but although only a few feeding experiments have been performed, there is every reason to believe that they are fully as destructive as the better known plants. Horses seem more likely to be affected by these plants than cattle, although in the Southwest there are a great many locoed cattle. Closely allied to the plant illustrated are a number of species which there is every reason to consider as true loco plants and which it is incumbent upon stockmen to prevent stock from eating.

SYMPTOMS OF LOCO POISONING.

All the loco plants produce similar effects. These symptoms appear only after a somewhat prolonged feeding upon the plant, and this fact has led to the failure of a great many feeding experiments with loco. Ordinarily the first symptom in a locoed animal is a loss of condition. This is followed by irregularities of gait and weakness which in many cases seems almost to amount to paralysis. The animal shows a lack of coordination in its muscular movements, due without doubt to the effect of the plant upon the central nervous

system. Horses formerly gentle become uncontrollable and will shy violently at imaginary objects or leap high over some slight obstruction. Generally speaking, a locoed horse can neither be led nor backed, and when put in motion can not easily be stopped or turned, but may continue until it runs against a fence or other obstruction.

Many animals acquire a liking for the plant to such an extent that they will eat nothing else. This, however, is not true in all cases. The animal, when affected, shows progressive emaciation and eventually starves to death. It is not at all unusual in a country where there are locoed cattle to see a steer standing off by itself, sometimes remaining in one position for hours, or even for days, and finally falling and dying without making any attempt to go elsewhere, either for food or water.

The losses from loco plants have been enormous. Some owners have gone into bankruptcy, and in many cases it has been found impossible to run horses or cattle upon certain ranges.

TREATMENT OF ANIMALS POISONED BY LOCO.

It does not always follow that animals eat the plants in any very large quantity, for even in a place like that shown in Plate II cattle may be pastured for a long time without any of them becoming affected. The most important point in regard to the handling of domestic animals upon such a loco range, as will be emphasized later in this paper, is to see that they have an abundance of good food. When the range contains in addition to the loco an abundance of grasses the number of locoed animals is very much reduced.

When the first symptoms of loco poisoning are observed, it is essential that the animals be removed to a place where they can not get the plants. Horses are very apt, after becoming slightly locoed, to continue eating the plant until they are absolutely worthless. It is always unsafe to turn a partly locoed horse upon a region that is covered with the plant. The same is true in regard to cattle, only to a lesser degree. As soon as symptoms of loco poisoning are seen in cattle they should be removed from the open range and, if possible, put upon alfalfa pasture. All locoed animals are constipated, and the alfalfa has a tendency to relieve this condition.

Generally speaking, if cattle are moved from the open range in time and fed upon alfalfa, the greater number of them will recover. After recovery it is well to put them upon the market as soon as possible, for if turned out upon the range again there is always a possibility that they may become locoed a second time, with worse results than at first. If the animals are valuable enough to justify the time spent in treating them, their recovery will be hastened, in the case of horses, by daily doses of 15 to 20 c. c. (4 to 6 drams)

of Fowler's solution, while cattle may be given hypodermic injections of strychnin. These doses should be continued for at least a month. Care should be taken in the use of strychnin, as locoed animals are very sensitive to its use. It is better that doses for cattle should not exceed three-twentieths or four-twentieths of a grain. Never, in the case of a large animal, should more than one-half grain be given.

In the case of locoed sheep upon the range, if the number is small, it is not profitable to spend any time or trouble with them. It is better to slaughter them immediately, as a locoed sheep will teach others the same habit. If, however, a number of locoed sheep can be separated and, like the cattle, be turned into an alfalfa field, most of them are likely to recover. Sheep may be helped by doses of one-twentieth grain of strychnin, but ordinarily, on account of the small value of individual animals, it is not profitable to spend the time which is necessary to insure their recovery.

In handling animals in a loco country it should be remembered that all domestic animals are more or less imitative, and loco eaters are likely to teach others to do the same thing. Therefore, so far as possible, all animals that have acquired the habit of loco eating should be separated from the others.

LARKSPURS.

A great many species of larkspurs grow in the western stock ranges, and they are widely distributed throughout the mountain regions which are used for pasturage. These plants when in blossom are very easily recognized by the peculiar form of the flower. Before blossoming there are a few plants with which they may be confused by a person who is not versed in botany, but it is not particularly difficult for the ordinary observer, after a little experience, to recognize larkspurs in all stages of growth. While there is a large number of species, all may be grouped under the two general heads of tall larkspurs and low larkspurs.

TALL LARKSPURS.

The tall larkspurs in their maturity reach a height of 4, or even 6 and 8 feet. They are perennials and grow in great abundance in the high mountain regions, ordinarily preferring damp and sheltered places, such as are found in mountain valleys and under trees. Under some circumstances, however, they may grow in considerable abundance in the open. All the tall larkspurs agree in the form of the leaf, which is well illustrated in Plates VII and VIII. The flowers, with the spur from which the plant gets its name, are very characteristic in their form and in most species vary in their colors through various shades of violet, blue, and purple. Before the plants are mature the leaves may be confused with those of the

OXYTROPIS BESSEYI.

This plant, closely resembling the white loco, grows in the same regions, especially in Montana and Wyoming, in close proximity to the white loco, and is frequently considered a loco plant. Experimental work has proved that it is harmless. It can be distinguished from the white loco by the dark color of the flowers, and by the fact that it is more likely to grow upon the dry summits of the hills, in more sterile locations than those in which the white loco is found.

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PURPLE LOCO, OR TEXAS LOCO (ASTRAGALUS MOLLISSIMUS).

This plant is sometimes known as the true loco, and grows abundantly in Texas and New Mexico. It seldom injures any animals except horses, but is very poisonous to them.

SACKETT & WILHELMS CORP. N.Y.

LOCO PLANT (ASTRAGALUS DIPHYSUS).

This is a type of a number of loco plants growing in the Southwest, which are particularly destructive to horses. Experimental work has proved that this poisons both horses and cattle.

TALL LARKSPUR (DELPHINIUM CUCULLATUM).

This is the tall larkspur which is abundant in Montana and adjoining States. It differs from the other tall larkspurs in the smaller size and less conspicuous coloring of the flowers.

SACKETT & WILHELMS CORP. N.Y.

TALL LARKSPUR (DELPHINIUM TROLLIIFOLIUM).

This is the tall larkspur of the Northwest, and is conspicuous because of its large and beautiful flowers.

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ACONITE (ACONITUM COLUMBIANUM).

The aconites grow in close proximity to the tall larkspurs, and are frequently confused with them. The leaves are almost identical in form, and the plants grow to the same height. They can, however, be distinguished by the form and color of the flowers. Although poisonous plants, the aconites do not poison cattle.

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TALL LARKSPUR (DELPHINIUM BARBEYI).

In this picture is a clump of this species of tall larkspur. Probably *Delphinium barbeyi* is the most widely distributed of the tall larkspurs, and is responsible for greater losses of cattle than any other. It extends from Colorado to the Sierras.

wild geranium, which in many places grows abundantly with the tall larkspur, but the different habit of the plant makes it comparatively easy to distinguish between them.

It is more difficult to distinguish between aconite and larkspur, because the leaves of the aconite are almost identical in form with those of the larkspur, and the habit of the plant is similar. In Plate IX is given a picture of the ordinary aconite in which this similarity will be noted. The leaves of aconite have shorter petioles (leaf stalks) than those of larkspur.

Species of tall larkspurs are found in all the mountain ranges of the West at high elevations, growing up as high as the timber line. Sometimes they are found as scattered clumps of plants, but frequently they grow in large masses.

Plate VII shows the leaf, flower, and seed pod of the tall larkspur which is most common in Montana and adjoining States, known to botanists as *Delphinium cucullatum*. This does not ordinarily grow to any considerable height—perhaps not more than 4 feet—and the flower is less conspicuous than in most of the tall larkspurs. The color is ordinarily described as a grayish purple, due to the fact that there is considerable white in connection with the violet-purple shades of the corolla. This plant is responsible for most of the deaths of cattle by larkspur in Montana. Plate VIII shows the tall larkspur of the Pacific coast region; it has a much more conspicuous and beautiful flower than *Delphinium cucullatum*.

Delphinium barbeyi is perhaps the most widely distributed species of the tall larkspurs and is the plant which causes the greater part of the tall-larkspur losses in Colorado, Utah, and some other localities. Plate X shows the plant as it grows in the midst of other plants in the high mountains of Colorado. In this picture it is growing in connection with aconite, Veratrum, and some other weeds.

In most cases the tall larkspurs blossom during the summer months and do not die down until they are broken by the snows of the early fall. The exact time of blossoming differs with the species and with the places in which they occur. In the mountains of Colorado the blossoming period is ordinarily in July, and the seeds are formed in August, after which the plant commences to dry up. The leaves of the tall larkspurs lose their poisonous properties after blossoming, so that in most localities the cases of poisoning from these plants occur in the spring or early summer. In the case of some species, however, especially in localities where the snowfall is heavy and remains late in the season, in certain parts of the Sierras, the period of blossoming continues into the late summer, so that poisoning cases may occur at any time during the season.

The seeds of the tall larkspurs are very poisonous, but they are not eaten to any extent, by cattle.

ACONITE.

Plate IX is a picture of the ordinary aconite and is inserted in order that it can be compared with the picture of the larkspur. Aconite, as is well known, is a poisonous plant, but somewhat extensive experimental work by the Department of Agriculture seems to have demonstrated that it does not poison live stock upon the range. It is important, therefore, that this plant should be distinguished from larkspur, because in some localities it occurs in great abundance, while larkspur is comparatively rare. This is true of certain parts of the Yellowstone Park, where in some localities the swampy regions are blue with aconite in the summer months, while the larkspur is only rarely met with. In other parts, however, like the region between the Yellowstone Lake and the Grand Canyon, the larkspur is very abundant and the aconite comparatively rare.

Flowers of the aconite have the peculiar form from which the plant has been known as "monkshood," and in most regions they are much darker in color than the larkspurs. Generally speaking, in the aconites of the West the flowers are of a very deep blue. There are localities, however, in which the shades of color are much lighter, almost the exact shades of the violet and purple that are more typical of the larkspurs, while in other places the flowers are almost white.

The roots of the tall larkspur are long, tough, and fibrous, while the roots of aconite are short and tuberlike, with golden-yellow rootlets. The stem of the tall larkspur is hollow, while the stem of the aconite is pithy.

LOW LARKSPUR.

Plate XI is a typical picture of the low larkspur which is most widely spread throughout the western ranges. This species is *Delphinium menziesii*, probably the most destructive of the low larkspurs, due to the fact that it occurs in such enormous masses. There are regions in Colorado and Utah where many acres are almost carpeted with these plants. They occur early in the spring, immediately after the snow disappears, growing more rapidly than the grasses, so that in some regions they seem for the time almost to preempt the soil. These low larkspurs blossom comparatively early in the season, and in Colorado *Delphinium menziesii* dries up and disappears not far from the 1st of July. Consequently the cases of poisoning from low larkspurs occur almost entirely in the months of May and June.

It will be noted that the leaves of the low larkspurs are quite different from those of the tall larkspurs, but are easily recognized after one becomes fairly familiar with them.

There is another low larkspur, occurring quite commonly in Montana, the *Delphinium bicolor*, which is typical of somewhat lower

altitudes than *Delphinium menziesii* and apparently never grows in sufficiently large masses to be dangerous.

The low larkspurs are poisonous throughout the whole period of their lives, while the tall larkspurs gradually lose their poisonous properties after blossoming.

In Plate XII is shown a larkspur with white blossoms, *Delphinium virescens*, which is quite common in the plains regions east of the Rocky Mountains. This plant probably rarely occurs in sufficient abundance to cause harm, but there is reason to think that at some seasons it has occasioned the death of a considerable number of animals.

PARTS OF LARKSPURS POISONOUS.

There is a general belief throughout the West that it is the roots of the larkspur which are particularly poisonous. Experiments have proved conclusively, however, that the different parts of the plant are equally poisonous, with the exception that the seeds are especially so. Probably in almost all cases of larkspur poisoning the trouble is caused by eating the leaves, sometimes with the flowers. As was intimated before, most of the cases of larkspur poisoning occur in the spring or early summer.

ANIMALS POISONED BY THE LARKSPURS.

While horses can be poisoned by corral feeding of larkspurs, there is reason to think that if left to themselves upon the range they never eat enough of these plants to do any harm. Sheep eat the larkspurs freely without suffering any evil consequences. There is quite a general belief in many regions of the West that losses of sheep have been caused by larkspur feeding, but extensive experiments upon a large number of species, and in different regions, have proved conclusively that sheep can be grazed upon larkspur without any risk whatever. In fact, it may almost be said that larkspur furnishes good forage for sheep. The losses from larkspur poisoning, then, are altogether with cattle, and these losses are very heavy.

SYMPTOMS OF LARKSPUR POISONING.

While the result of corral feeding shows that there are a number of preliminary symptoms, as animals are noticed upon the range the first symptom commonly observed is the sudden falling of the animal, accompanied by violent struggles. The animal is unable to rise, but after a few moments may get upon its feet and walk away, and show no further symptoms. In more acute cases of poisoning the first fall will be followed by a second, and that possibly by a succession of falls, which in severe cases of poisoning are followed by complete prostration, vomiting, and death.

TREATMENT OF CATTLE POISONED BY LARKSPUR.

Inasmuch as death from larkspur poisoning is caused by respiratory paralysis, it is very important, if the animal is found poisoned by this plant, that immediate means shall be taken to relieve the difficulty in respiration. In their struggles animals poisoned by larkspur ordinarily throw themselves with their heads downhill, and in this position the stomach and intestines press upon the lungs and seriously interfere with the function of respiration. If while in this position the animal should vomit, some of the regurgitated material is very apt to fall back into the windpipe and cause asphyxiation. When, therefore, an animal is seen to fall from larkspur poisoning, it should be turned about with its head uphill and erect and should then be left undisturbed. It is also desirable under such conditions to give the physostigmin remedy hypodermically, as recommended in Farmers' Bulletin 531. The remedy has the following formula:

Physostigmin salicylate	1 grain.
Pilocarpin hydrochlorid	2 grains.
Strychnin sulphate	½ grain.

This formula would apply to an animal weighing 500 or 600 pounds. For a large steer or cow of 1,000 pounds or more the dose should be twice that given in the formula. These materials can be obtained from any dealer in drugs. The physostigmin salicylate and pilocarpin hydrochlorid are furnished in veterinary hypodermic tablets, each containing one-half grain of physostigmin salicylate and 1 grain of pilocarpin hydrochlorid. The strychnin sulphate can be obtained in tablets each containing one-half grain. These dissolve easily, and it is well to have two or three doses ready in small homeopathic bottles. For yearlings one should use two of the physostigmin-pilocarpin tablets and one of the half-grain strychnin tablets dissolved in enough water to fill an 8-dram homeopathic bottle; for full-grown cattle four of the physostigmin-pilocarpin tablets and two of the strychnin tablets dissolved in an 8-dram bottle full of water should be used.

It is best to use an all-metal hypodermic syringe. This can be easily cleaned by boiling. The form which has been found most useful for the field is that known as the Quitman syringe. In this the needles are carried in the hollow piston, and a case is therefore unnecessary. The syringe should be of the 10-centimeter size, which holds half an 8-dram bottle of water, so that the remedy can be given to yearlings in a single dose, while for mature cattle the syringe must be filled twice. The needle is most conveniently inserted in the shoulder. There is little doubt that prompt treatment of animals poisoned by larkspur will result in the saving of most of the cases.

LOW LARKSPUR (DELPHINIUM MENZIESII).

This is the most common of the low larkspurs, extending from Colorado to the Sierras, and causes heavy losses of cattle.

SACKETT & WILHELMS CORP. N.Y.

PRAIRIE LARKSPUR (DELPHINIUM VIRESCENS).

The white larkspur of the plains, which is found as far south as Texas. It is probably responsible for occasional losses of cattle in those regions.

CICUTA (WATER HEMLOCK).

The most poisonous of all the plants in the United States is, without any doubt, the Cicuta, which is most commonly known throughout the West as "parsnip"; sometimes as "water hemlock." There are several species of Cicuta recognized by our botanists, but they are very closely allied, and for the purpose of stockmen the description of one will serve for all. Plates XIII and XIV are of the Cicuta, which is common on the Pacific slope.

Cicuta is an umbelliferous plant growing in swamps and damp valleys and frequently very abundantly along irrigating ditches. A large number of umbelliferous plants occur in these localities, and it is difficult for the nonbotanical person to distinguish Cicuta from other similar nonpoisonous plants. Probably the easiest way to distinguish the plant is by an examination of the rootstock. The Cicuta grows from a rootstock to which are attached roots which may be small, as shown in Plate XIV, or may take the form of a group of thick, fleshy tubers. In longitudinal section this rootstock shows more or less distinctly a number of transverse chambers, as shown in Plate XIV. By this peculiarity of structure Cicuta can be distinguished from most plants growing in places where it is likely to be found.

POISONING BY CICUTA.

It has been commonly thought that the tops of Cicuta when found in hay caused the loss of stock, but experimental work of the department has shown quite conclusively that the tops and seeds never occasion losses. The rootstock, however, is violently poisonous, and a very small quantity of this is sufficient to kill any animal that eats it. Probably all animals are susceptible to the effects of this plant. The losses of domestic animals are mainly of cattle, which either obtain the rootstocks that have been plowed up along irrigating ditches or find them along watercourses in mountain valleys where they have been washed out by the high water.

SYMPTOMS, TREATMENT, AND LOSSES.

The symptoms of Cicuta poisoning are frothing at the mouth and most violent convulsions, which in a short time ordinarily end in death

When cattle are severely poisoned the convulsions are so violent that it is almost impossible to administer a remedy; in fact, no effective remedy is known, and death is almost certain to follow cases of severe poisoning by this plant. It frequently happens that human beings, especially children, are poisoned by Cicuta, in which case if an emetic can be given promptly, so that the stomach is quickly emptied, recovery usually takes place. Because of the fact that ruminant animals can not empty the stomach by vomiting, this remedy can not be applied to them.

The losses from Cicuta poisoning are not ordinarily very heavy, but individual stockmen occasionally lose quite a number of animals.

DEATH CAMAS (ZYGADENUS).

The larger part of the losses of sheep from poisonous plants during the spring and early summer months is due to the various species of Zygadenus, or death camas.

Plate XV, a picture of *Zygadenus venenosus*, gives a clear idea of the general appearance of these plants. This species is common in the foothill regions of the range country of the West and sometimes occurs in great abundance. It starts early in the spring, before the grasses, and matures during the months of May and June. By reason of its green, grasslike leaves it is not easily recognized in the early stages of its growth. When fully grown it is somewhat conspicuous on account of its yellowish-green flowers, which make it a plant easily distinguished from others. This is especially true when it is growing in quantity, for acres may be covered with these rather striking blossoms.

ZYGADENUS ELEGANS.

Another species, *Zygadenus elegans*, resembling the *venenosus* in its general characteristics, is found at higher elevations in the mountains, and grows in a similar way, but is somewhat later in maturing.

ZYGADENUS PANICULATUS.

Zygadenus paniculatus, of the States farther west, a picture of which is given in Plate XVI, resembles very closely the *venenosus* and *elegans*, but differs mainly in the more extended panicle of flowers. The illustration also shows the seed pods of Zygadenus.

These plants are found in practically all the grazing States of the West, and, unfortunately, in many regions they have not been recognized as injurious. In the Northwest, where recognized, the popular term "lobelia" has been applied to Zygadenus. Sometimes it is known as "poison sego."

SYMPTOMS OF ZYGADENUS POISONING.

The prominent symptoms of Zygadenus poisoning, as seen upon the range, are frothing at the mouth, nausea accompanied by vomiting, great weakness accompanied sometimes with nervousness and resulting in collapse of the animal, which may lie without food for hours, or even days, before death terminates the case. It is not unusual for large numbers of sheep in a band to be poisoned by Zygadenus, and in such case the result is almost always heavy losses. Perhaps more cases of Zygadenus poisoning have been reported from Montana than from other States, but this is simply because the cases have been under observation in that locality; the losses are probably just as heavy in Utah, California, and elsewhere.

TREATMENT FOR ZYGADENUS POISONING.

There are no medicinal remedies which can be used effectively for Zygadenus poisoning. The important thing is to avoid the possibility of the sheep eating any large quantity of the plant. Unfortunately, the plant is quite toxic, so that comparatively small quantities may produce harm.

LUPINES.

The lupines are among the most conspicuous of the flowering plants upon mountain ranges. They are scattered in a very large number of species practically over all the grazing regions. They are known under a great variety of common names, among which are "blue pea" and "wild bean."

The picture of *Lupinus sericeus*, Plate XVII, will serve for the identification of any of the lupines. The form of the leaf and the color of the flower, ordinarily shades of purple or blue, readily distinguish this plant from others growing in the same neighborhood. The seeds are especially poisonous, and most cases of poisoning result from eating the pods containing seeds. The pods alone, however, may poison, and sometimes sheep are poisoned by the leaves, or by the leaves in combination with the seed pods.

The losses from lupine poisoning are mostly of sheep, although some horses are poisoned. It is probable that the lupines are the principal cause of sheep losses in the late summer and fall months. It is not by any means to be understood that sheep are always poisoned when they come upon a patch of lupine, for bands of sheep may feed through lupine for a whole season without any harm. When, however, a hungry band comes upon a patch of lupine at the time when the pods are filled with seeds, poisoning frequently occurs. Cases of poisoning sometimes happen when sheep are taken from the cars and allowed to graze freely upon lupine. Many cases of poisoning have occurred when the sheep are brought down from the mountains in the fall. If during that passage the band is overtaken by a snowstorm, sometimes it will feed freely upon the lupine pods which remain above the snow, and heavy losses may occur. It is not unusual for several hundred out of a band to be killed by lupine poisoning. These losses are not confined to any one State, but occur in practically all the Western States where sheep are grazed upon the range.

SYMPTOMS OF LUPINE POISONING.

The symptoms of lupine poisoning resemble in many respects those produced by some other poisonous plants. There is frothing at the mouth, but in addition the animals run about in a frenzy, butting against any opposing object in a way which seems to be characteristic of this disease.

TREATMENT FOR LUPINE POISONING.

No medicinal remedies have been found for cases of lupine poisoning. The only thing for a sheep herder to do is to make certain in advance that the animals under his care shall not come upon a patch of lupine in pod at a time when they are particularly hungry.

LAURELS.

Among the plants classed as laurels are a number which are important as poisonous plants and occasion heavy losses, more especially of sheep. All these plants contain a poisonous substance known as andromedotoxin. The following brief statements concern the laurels which are known to cause losses on the western ranges.

MENZIESIA GLABELLA.

This shrub, which grows in the mountains of the extreme Northwest, has been found to be distinctly poisonous to sheep. It is not known that many losses have occurred from eating this plant, but it was demonstrated in one case in Idaho that the plant was the cause of very heavy losses, and there is no doubt that when sheep in those regions are pastured on the north slopes where Menziesia is more likely to grow, and are short of other food, disastrous results may follow. Plate XVIII shows this plant in flower.

BLACK LAUREL (LEUCOTHOE DAVISIAE).

This plant, generally known through the Sierras as "black laurel," is particularly destructive to sheep. It has thick, dark-green, oval leaves and small white flowers in erect racemes, as shown in Plate XIX, and grows to a height of about 3 or 4 feet. It is found in small patches at elevations from about 3,500 to 5,000 feet in the northern Sierras in California. While far from common, it is yet a very important plant because of its extremely toxic character. It has been stated that a single leaf will poison a sheep. This statement is probably exaggerated, but experimental work shows that very small quantities will poison sheep and that death may be produced by between one and two ounces.

LEDUM GLANDULOSUM.

This plant, illustrated in Plate XX, is also known in California as black laurel and probably is not generally distinguished from *Leucothoe davisiae* by the sheepmen, although it has a very different habit. It is rather widely distributed, being found not only in the Sierras and Coast Ranges in California, but also in Oregon, Washington, Nevada, and the Rocky Mountains. While no experimental work has been done with this plant, there seems to be no question that it causes serious losses of sheep in California.

CICUTA VAGANS.

The species of Cicuta growing in the northwestern United States. Cicuta, commonly known to stockmen as parsnip, is the most poisonous of all our native plants, and grows in damp valleys and along irrigating ditches.

SACKETT & WILHELMS CORP. N.Y.

CICUTA VAGANS.

A young plant with the rootstock, and a longitudinal section of the rootstock. By the transverse chambers shown in the longitudinal section of the rootstock the Cicuta can readily be distinguished from any other plant growing in the same locality.

SACKETT & WILHELMS CORP. N.Y.

DEATH CAMAS (ZYGADENUS VENENOSUS).

This species of death camas, growing in the foothills, causes heavy losses of sheep during the spring season.

SACKETT & WILHELMS CORP. N.Y.

DEATH CAMAS (ZYGADENUS PANICULATUS).

This plant has the same properties as *Zygadenus venenosus*, and within its range is equally destructive. It is to be noted that the seeds of the species of Zygadenus are especially poisonous.

LUPINE (LUPINUS SERICEUS).

All the species of Lupine are supposed to be poisonous, and are the cause of the larger part of the heavy losses of sheep during the late summer and fall months. Sheep are most likely to be poisoned by eating the pods and seeds.

SACKETT & WILHELMS CORP. N.Y.

MENZIESIA GLABELLA.

One of the laurels growing in northwestern United States, which has been known to occasion heavy losses of sheep.

BLACK LAUREL (LEUCOTHOE DAVISIAE).

This is one of the black laurels, and causes heavy losses of sheep in the Sierras.

BLACK LAUREL (LEDUM GLANDULOSUM).

One of the black laurels which, together with Leucothoe, cause probably the major part of the losses of sheep in the Sierras.

WHITE LAUREL (AZALEA OCCIDENTALIS).

It grows at a lower elevation than the black laurels, and causes heavy losses of sheep in the Sierras.

SACKETT & WILHELMS CORP. N.Y.

RHODODENDRON ALBIFLORUM.

A laurel causing losses of sheep in the Northwest.

COMMON FERN (PTERIS AQUILINA).

The common fern, particularly in the regions of the Northwest, sometimes causes losses of horses and cattle.

WHITE LAUREL.

White laurel (*Azalea occidentalis*) is illustrated in Plate XXI. It is found in the Coast Ranges and the Sierras, growing at a slightly lower level than the black laurels, and causes considerable losses of sheep.

RHODODENDRON ALBIFLORUM.

Rhododendron albiflorum, illustrated in Plate XXII, is common in the mountains of the Northwest and has undoubtedly caused some losses, although it is not very generally recognized as a poisonous plant. Preliminary experiments apparently show that it is more poisonous than Menziesia, but less so than the black laurels.

SYMPTOMS OF LAUREL POISONING.

The symptoms are practically the same in all cases of laurel poisoning. There is salivation resulting in frothing at the mouth, nausea ordinarily accompanied by vomiting, depression, weakness shown by a staggering gait or inability to stand, and irregular respiration. Grinding of the teeth is frequently noticed in sick animals.

TREATMENT OF LAUREL POISONING.

Little can be done in the way of remedial treatment. Anything that will aid in elimination will be of some benefit, and to this end purgatives may be given, such as Epsom salt in doses of 4 ounces. The main reliance, however, must be placed on prevention. Herders should learn to recognize and avoid the plants.

FERN.

The common bracken fern, *Pteris aquilina*, which is illustrated in Plate XXIII, should be mentioned here as one of the poisonous plants, although the losses from it are probably not large. It has long been known abroad that the fern is poisonous to cattle and horses. There have been comparatively few reports in this country of such losses, and those are largely confined to the Northwest. There is no doubt that ferns will poison both cattle and horses, and probably sheep, and care should be taken that hungry animals shall not have an opportunity to consume any large quantity.

WILD CHERRY.

For years there have been persistent reports of poisoning, especially of sheep, from eating wild-cherry leaves. There has been great difficulty in proving the truth of these stories, for it has frequently happened that of several bands going through a mass of wild cherry, possibly only one would suffer, while the others would go through in an entirely safe manner. A large number of experiments have been

performed with wild-cherry leaves, many of which have been without results. Investigations by the department, however, have proved beyond question that the leaves of wild cherry are extremely poisonous, and there seems to be no doubt that, under certain circumstances, animals may be killed by eating this plant. These cases ordinarily occur along drives that are bordered by wild cherry and where there is very little else for the animals to eat.

Sheepmen should by all means avoid, if possible, trails that are lined with wild cherry, and if it is necessary to drive over these trails, they should take great care that the animals are well supplied with food before commencing the drive. Poisoning from wild cherry is due to prussic acid, and death results very quickly. No treatment is likely to modify the results. Plate XXIV shows one of the wild cherries of the West.

MILKWEED (ASCLEPIAS).

Several of the species of milkweed are said to cause losses of live stock, especially of sheep. The poisonous character of the whorled milkweed (*Asclepias galioides*) has been definitely proved. This plant, shown in Plate XXV, grows in the dry plains and foothills of Arizona, New Mexico, southern Utah, and southwestern Colorado, and has become especially abundant in some of the irrigated lands. It is very poisonous, and, while not eaten from choice, has caused heavy losses of sheep, when, in a hungry condition, they have been confined to a milkweed area. It is also poisonous to horses and cattle, but the principal losses have been of sheep.

WOODY ASTER (XYLORRHIZA PARREYI).

The woody aster, shown in Plate XXVI, occurs in great abundance in certain regions in Wyoming, and has been accused of causing losses of sheep in those localities. There appears to be no doubt that the plant is poisonous. It is a fibrous plant, however, and is very distasteful to sheep under ordinary circumstances, so there is very little danger from it, provided the sheep are kept in a region where sufficient feed is obtainable.

COLORADO RUBBER PLANT, OR PINGUE (HYMENOXYS FLORIBUNDA).

This plant, shown in Plate XXVII, is confined to the northern part of New Mexico and the southern part of Colorado and Utah, and in certain localities grows in very great abundance. Its aster-like flowers are quite conspicuous, and the plant is readily distinguished from other similar plants because of the dark golden-yellow color of the flowers. The rubber plant has had a good deal of advertising because it contains a certain amount of rubber and has been the

subject of commercial exploitation. It is claimed, especially in southern Colorado and northern New Mexico, that sheep feeding upon this plant in the late winter suffer severely.

Experimental work has proved that the plant is poisonous to sheep, but it has been found difficult, under corral conditions, to make them eat it. Field observations have shown that in the localities where animals are reported to have suffered, the sheep in the latter part of the winter are frequently kept under conditions closely approaching starvation, and at such times doubtless, by force of circumstances, they would eat more of the plant. It is very much to be doubted if there would be any losses from this plant if bands were properly fed.

WESTERN SNEEZEWEED (DUGALDIA HOOPESII).

Western sneezeweed, sometimes called "yellow weed" by the stockmen, is found in great abundance on the sheep ranges of the Wasatch mountains in Utah, especially in localities where the range has been heavily grazed. The plant is distributed in greater or less numbers from Wyoming in the North to New Mexico and Arizona in the South, and as far west as California, but it is in Utah that it has become prominent as a poisonous plant.

The plant, shown in Plates XXVIII and XXIX, is a stout perennial composite, growing to 2 or 3 feet in height, with thick deep-green leaves. The rays of the flower are of an orange color and the disk a brownish orange; the blossoming period in the Wasatch mountains ends the middle or last of August. Its range in elevation is from 7,000 to 10,500 feet.

Under ordinary range conditions the western sneezeweed seems to be dangerous only to sheep. It has been found to be the cause of what is known in Utah as the "spewing sickness" of sheep, from which there have been quite heavy losses.

SYMPTOMS OF POISONING BY DUGALDIA.

The marked symptoms of Dugaldia poisoning are depression, weakness, salivation, and nausea accompanied with vomiting; this latter symptom is so prominent as to have given the disease its popular name. Diarrhea is common, and bloating is a prominent symptom in the animals poisoned on the range. The poison is cumulative, and its effects continue for a long time.

TREATMENT FOR DUGALDIA POISONING.

No medicinal remedy for the disease has been found. It is the custom of sheepmen on the Wasatch mountains, when their sheep are found to be "spewing," to take them to lower altitudes on "browse range," when their condition is improved. It is recognized,

however, that this treatment does not bring about a real cure. It is important that herders should recognize the plant and so far as possible avoid ranges or parts of ranges where it is especially abundant. Generally speaking, when a band of sheep is found to be suffering from this plant it is because they have been eating it for some time, and perhaps a single large feeding may have precipitated the trouble, which is mainly due to the accumulated effect of prolonged feeding.

OAK.

Throughout the grazing regions of the West there is a very general belief in the poisonous properties of oak leaves, more particularly in regard to their supposed toxic properties for cattle. It is quite generally thought that poisonous effects are produced in the spring when cattle are eating the buds and young leaves. This belief applies especially to the Gambel oak (*Quercus gambellii*), which is a common scrub oak of Colorado, Utah, and New Mexico, and to the shinnery oak (*Quercus havardi*), a low shrub in eastern New Mexico and western Texas. Extended experiments are being carried out upon these plants by the U. S. Department of Agriculture. These experiments are still in progress, and the results can not be considered as definitely conclusive. It seems probable, however, that oak leaves do not have any distinctly poisonous properties, but, on the contrary, especially when the leaves are mature, form a valuable element in the forage of range animals. When cattle are fed exclusively on oak leaves they suffer from constipation, so that on an overgrazed range this condition may become so serious as to produce illness and death. No serious results need be expected, however, provided the forage is sufficiently abundant so that there is enough variety to preclude the exclusive use of oak.

PSORALEA TENUIFOLIA.

This is a very common plant on the plains of Colorado, Wyoming, and Montana, and is found as far east as Illinois. There have been many reports of its poisonous effects on horses and cattle, and it is said to have been used by the Indians for poisoning fish. Several species of Psoralea have been examined by chemists, and have been found to contain poisonous principles. One of the species has been popularly known as a loco weed. There has been no experimental work to prove its effect on domestic animals, and as it is distasteful to grazing animals it can not, under any circumstances, be considered an important poisonous plant. There is good reason, however, to suspect it of sometimes being harmful, if animals are forced to eat it by reason of poor pasturage or because it is present in large quantity in hay. Plate XXX is a picture of this plant.

WILD CHERRY (PRUNUS NANA).

The wild cherries grow in great abundance upon the stock ranges of the mountain regions and sometimes occasion quite heavy losses.

SACKETT & WILHELMS CORP. N.Y.

WHORLED MILKWEED (ASCLEPIAS GALIOIDES.)

This plant is very poisonous to cattle, horses, and sheep, and has caused some extremely heavy losses of sheep in the West and Southwest.

WOODY ASTER (XYLORRHIZA PARREYI).

The woody aster has been considered to cause losses of sheep in Wyoming. It is probable that sheep eat it only when there is a lack of other forage.

COLORADO RUBBER PLANT OR PINGUE (HYMENOXYS FLORIBUNDA).

For a long time the Colorado rubber plant has been accused of causing losses of sheep in northern New Mexico and southern Colorado.

SACKETT & WILHELMS CORP. N.Y.

WESTERN SNEEZEWEED (DUGALDIA HOOPESII).

This, especially in Utah, causes serious losses of sheep.

SACKETT & WILHELMS CORP. N.Y.

WESTERN SNEEZEWEED (DUGALDIA HOOPESII).

This shows how thickly it grows where land is heavily grazed.

PSORALEA TENUIFLORA.

A very common plant on the plains, supposed to be poisonous under some circumstances.

PREVENTION OF LOSSES.

In Farmers' Bulletins 536 and 720 attention was directed to the fact that most of the losses from poisonous plants occur at times when the animals are short of feed, and it was suggested that the larger part of the stock poisoning is indirectly due to scarcity of proper forage. This fact of the intimate relation of scarcity of feed to stock poisoning can not be too strongly impressed upon the people who handle range animals in the West.

There is apparently a popular idea that range animals will voluntarily seek out poisonous plants and eat them by preference. It may be stated as a general fact that this is not true. Animals seldom eat poisonous plants except as they are driven to do so by lack of other food. Almost all poisonous plants are actually distasteful to live stock and under ordinary circumstances will be avoided. The only exception to this, perhaps, is the group of loco plants. Animals do frequently acquire a taste for loco and under some circumstances will eat nothing else, even in the presence of other forage; and yet the initial feeding in the case of loco plants is almost invariably brought about by scarcity of food.

It has long been known that loco eating is ordinarily commenced in the winter season or in the early spring when the loco plants are green and luscious, and before the grass has started. The loco plants at that time are the most prominent plants on the plains, and animals commence to eat them because of lack of other food. Many animals after feeding upon loco a short time acquire a liking for it and will continue to eat it even in the presence of an abundance of other food. This is not true, however, even of all loco-eating animals, for there are very many which, after the grass has started, will leave the loco and will recover entirely from the effects which have been produced by the preceding feeding.

In the matter of the other plants, the relation between starvation and the eating of the poisonous plant is still more marked. For instance, the larkspurs spring up immediately after the snow leaves the mountains and grow much more rapidly than the surrounding grasses, and if cattle are allowed to go up to the upper ranges before the grasses have had a fair start, they find already occupying the ground the succulent larkspur plants in huge numbers. Sometimes the cattle come from dry winter feed and are anxious to gorge themselves with any green material they find. Under such circumstances if they come upon a field of larkspur they frequently eat enough to produce fatal consequences. Later in the season there is very much less danger from larkspur because of the abundance of other food. If, however, cattle are driven from one range to another and the trail passes through a mass of tall larkspur, it is not

at all unusual for the hungry animals to grab hastily at the plants, and this may result in disastrous consequences. Under such circumstances it is important that the cattle shall not be driven rapidly, for then they will snatch all the more, and they should also have been thoroughly fed before going upon such a drive.

This has been illustrated in certain places in Colorado, where it is customary to drive cattle from one range to another, and for years there were always heavy losses. In the old days it was the custom to gather the cattle together and rush them as rapidly as possible through the place where the tall larkspur was growing. Losses invariably occurred. In recent years, instead of gathering the cattle together they have been put through the drive in small numbers and have been allowed to feed before starting. They are not driven rapidly. Under such conditions no losses have occurred.

It is also evident, from what has been said earlier in this paper, that if cattle can be kept off fields of larkspur until after the plant has blossomed, little trouble may be expected. This method has been employed for many years in certain regions in Colorado, where it is a common practice to "ride for poison," as it is called; that is, the herders ride and keep the cattle down from the higher ranges until the larkspur has blossomed and matured, after which there is no further danger. The same thing has been accomplished in certain regions by putting up drift fences which are designed to keep the cattle on the lower ranges until the danger is past. There are valleys known as death traps for cattle. Frequently it will be found that in these valleys the tall larkspur is thriving in large clumps, and cattle drifting in will feed freely upon it. It is often possible under such conditions to clear out this larkspur, or enough of it so there will be no danger. In order to kill the plants, the roots of most of the species should be cut off at least 6 or 8 inches below the surface.

Deaths from Cicuta poisoning rarely occur except in the case of animals that are almost in a starving condition. If very hungry animals are turned loose upon a range, and they find a number of Cicuta roots lying beside a ditch or along a mountain stream, and there is nothing else to eat, they eat these roots, of course, and death follows.

The losses of sheep from death camas (Zygadenus) occur under very similar conditions to those of cattle from larkspur. Zygadenus grows very early in the spring. It precedes the grasses in its growth and is present in a succulent condition at a time when other forage is extremely scarce. Inasmuch as it occurs frequently in large masses, if sheep are trailed over these places they are liable to get enough to cause heavy losses. It is particularly important in the handling of sheep in such localities that, if possible, they be grazed in loose order. In fact, this applies to the handling of sheep under all circumstances. When the animals are massed together they will

eat everything in their course, and, because of jealousy, will take particular pains to get every available plant. If, on the other hand, they are kept in loose order and spread widely over the range, they are much less likely to eat any poisonous plant.

This applies equally well to lupine poisoning. When sheep are allowed to feed freely upon a lupine patch and are moved without any haste, no harmful results will occur. If, however, they are massed together and driven in close formation over such a patch, they are almost certain to be poisoned if the plants are in pod at the time. A large number of specific instances have been noted. At one place in Idaho, for instance, where losses have occurred repeatedly, it was found that the sheep were trailed in a narrow space through a patch of lupine. The remedy in such cases clearly is to see that the sheep, when it is necessary to trail them through a patch of lupine, are drifted rather than driven, and that they are well fed when they come upon this locality. It seems probable that intelligent handling of bands of sheep may reduce to almost nothing the losses occasioned by Zygadenus and lupine. If, however, hungry sheep come in contact with fields of Zygadenus in the spring, or with fields of lupine in the late summer and fall, at a time when the plants are bearing pods, fatal results must be expected.

In one locality in Oregon an instance of this character occurred in the summer of 1914, when something like 4,000 sheep which had been driven rather rapidly along a trail where forage was scarce were turned into a 10-acre pasture on which there was little but sagebrush and lupine, the lupine at that time being in pod. About 400 out of the 4,000 sheep died. Similar instances might be cited in a large number of places. Sometimes successive bands of sheep are driven over a trail, several going without any loss whatever; then one band may suffer heavily, while others following are not harmed. The explanation of these cases seems to be that the first animals going over the trail avail themselves of all the useful forage. The succeeding animals, finding nothing suitable for food, take the poisonous plants, which may be wild cherry or lupine, or, in the case of cattle, larkspur. The animals which are poisoned may exhaust the supply, even of the poisonous plants, so that succeeding bands are not poisoned and get across the trail safely provided they do not fall from actual starvation.

It follows from these facts that it is very undesirable to keep sheep for any length of time upon the same bedding ground. This has been shown to be bad for the range on general principles, but it is also rather risky for the sheep themselves, for if animals go out from the same place day after day and return at night they will eat everything that is available along the route. In such cases, if there are poisonous plants to be obtained, the animals are pretty apt at some

time to get hold of them, with disastrous results. This has been very clearly shown in a case of Menziesia (laurel) poisoning, in which animals were bedded on a forest range for five nights in the same place; the animals were safe for the first two nights, but after that there was heavy loss. At the same time a band that was wandering about without a herder in the same region was uninjured.

It can not be too strongly impressed upon persons handling sheep upon the range that the sheep should be allowed to graze as far as possible under strictly natural conditions. By this is meant that they should be allowed to go freely, separated from each other, moving slowly, and not allowed to graze over and over upon the same ground. The so-called blanket system of herding, which is advocated by the Forest Service, in addition to the fact that it aids in the conservation of the range, will also without any doubt reduce the losses from poisonous plants to a minimum, if it does not entirely do away with them.

CONCLUSION.

In conclusion, it should be stated that, generally speaking, very little must be expected from medicinal remedies to reduce the losses from poisonous plants. It is true that such remedies will help in the case of locoed animals and will save life in the case of larkspur poisoning of cattle. Generally speaking, however, the reliance should be placed not in remedies, but upon prevention. Animals must be so well cared for that they will not wish to eat poisonous plants. Something may be done in the way of eradication, as was indicated under the discussion of larkspur. Larkspur can doubtless be eradicated within a limited area. The locoes in pastures can be eradicated with very little difficulty, but upon the open range dependence must be placed upon avoidance rather than eradication. Zygadenus, too, does its harm upon the open range, and there it occurs in such large masses that eradication is impossible. In the matter of Cicuta, farmers might, without doubt, accomplish much by digging it up along their irrigation ditches, and this practice is usual in a great many localities. But in the main the losses from poisonous plants must be prevented by careful handling of the herds, remembering always that animals are not likely to eat poisonous plants by preference, but that under starvation conditions they may be driven to the use of such material for forage with most disastrous results.

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